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# THE SOYUZ AND APOLLO SPACECRAFT

I. Yudin

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16. Abstract

The Soyuz and Apollo spacecraft as well as the docking module are extensively described by Correspondent I. Yudin. The exterior structure and interior design of the Soyuz spacecraft are described section by section. The Apollo and the docking module are described in similar detail. A two-page cutaway drawing illustrating both spacecraft and the flight program is included; six detailed cutaway diagrams of the Soyuz and Apollo interiors are also included. All diagrams include dozens of nomenclature designations.

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THE SOYUZ AND APOLLO SPACECRAFT

I. Yudin

On July 15, 1975, a joint experimental flight of the Soviet spacecraft the Soyuz and the American Apollo spacecraft is planned. It is conducted on the basis of an agreement between the USSR and the USA on coordination in research and use of outer space for peaceful purposes. This is the first joint flight of spacecraft from different countries. /36*

The technical director of the Soyuz-Apollo project on the Soviet side, Associate Member of the AN SSSR [Akademiya nauk USSR, Academy of Sciences of the USSR], Konstantin Davydovich Bushuyev, has already discussed in a journal the requirements which must be met by the craft for carrying out the joint space experiments and for giving help to each other (see the article "Cooperation in Space," in Nauka i zhizn, No. 4, 1973).

Here we offer to take the reader on a tour of the Soyuz and Apollo to become familar with their devices, and also with those changes which are being made in their structure in connection with the coming experiment.

Very little time remains before the beginning of the first joint Soviet-American space experiment. But in the meantime the spacecraft which are to meet in space--the Soyuz and the Apollo, are on Earth. And, taking advantage of this, let us look at the spacecraft and acquaint ourselves more closely with them.

Before our excursion begins, let us say a few words, literally, on the general principles of planning manned spacecraft.

The structure of the entire spacecraft, and each of its parts, is determined by conditions of space flight. On board, the artificial atmosphere must be constantly renewed, must provide meteor and radiation protection, dissipation of heat from the surface of the vehicle. In orbit, the spacecraft flies due to inertia

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*Numbers in the margin indicate pagination in the foreign text.

without loss of energy, comparable to a weightless body. However, for changing its trajectory or velocity of flight it is necessary not only to expend energy but also to discard a certain mass. This means that the spacecraft must have adequately powerful jet engines for maneuvering in orbit and for exit from it. In order to change the position of the spacecraft in space, or to put it another way, to orient it, jet engines are also necessary though, in truth, with considerably smaller thrust.

The shape of the spacecraft is determined by the conditions of its flight both in space and in the atmosphere. In truth, the latter applies not to the whole ship, but only to that part which will rotate around the Earth.

The re-entry unit of the spacecraft must be as compact as possible. In particular, this permits decreasing the area of the surface which must be protected from the effects of large heat flows during re-entry. The spacecraft must be as light as possible if only for the giant parachutes necessary for landing. Beside when selecting the shape of all the compartments of the spacecraft, the designers try to obtain a maximum ratio of volume to area of the mid section, that is, to the area of the cross section of the module. This permits decreasing danger from meteors in orbit.

There also exist certain general limitations in ratio of weight to volume due to the large energy losses on putting the units into orbit. For one kilogram of weight it is suitable to have a load of approximately 25 kilograms of starting weight, and the cost for putting each kilogram of weight into orbit around the Earth is evaluated by American data as 1500 dollars.

The Soyuz spacecraft is a multipurpose space orbital craft. It replaced the legendary Vostok and Voskhod and marked its own new stage in the development of manned spacecraft. The Soviet cosmonauts have completed many flights on the Soyuz including /37 group flights and have also worked out complex elements such as search, approach and docking in orbit, have fulfilled a broad program of scientific research and technical experiments, have made tests and developed multiple systems. The Soyuz was the basis for putting together the first experimental space station in the world; and with the creation of the Salyut station is utilized as the transport craft for equipping it and delivering crews. The Soyuz was developed by designers as a special type of spacecraft combining in it the elements of a transport ship and an orbital station. And now it has still another task--rendezvous and docking in orbit with a spacecraft from another country.

We are at the test-installation command at the spaceport, called for short the MIK [Montazhno-ispytatel'nyy korpus, test-installation command]. The Soyuz stands vertically. Its modules appear to be stacked one on the other. There are three of them.

Slowly moving upward along the forest of the assembly stand around the ship we begin our excursion on the Soyuz.

Before us is the instrument-system module. It has a cylindrical shape with an end skirt and the structure is divided into three smaller sections: transfer, instrument and system. On a girder of the transfer section, in the area of the center of mass of the ship, most of the engines for mooring and orientation are located.

The aggregate of systems of temperature regulation, electrical supply radio communication and radio telemetry equipment, instruments for the orientation and movement control systems--everything that is needed for operating with particularly suitable conditions is included in the hermetically sealed instrument section which has the shape of a cylinder.

In the systems sections is an engine unit for correction in orbit and braking during re-entry engines for mooring and orientation, fuel tanks, hydraulic systems for temperature regulation, on-board storage batteries. A basic and duplicate engine with thrust 400 kg are part of the engine set-up of the Soyuz. On the spacecraft there are 14 engines for mooring and orientation with thrust of 13 kg each and 8 for orientation with thrust 1.5 kg each. On the outside of the transfer and instrument-system sections one sees a large ribbed radiator-emitter system for heat regulation of the vehicle. It "throws off" excess heat generated by the equipment on board and by the elements of the structure.

Solar batteries with useful area of about 9 square meters are attached to the instrument-system module. Along with the storage batteries they provide electrical energy to the equipment on board the Soyuz. The voltage for the circuits on board is direct, about 27 volts.

Outside the instrument-system module are mounted antennas for the various radio systems: radio-telephone communication of the crew with Earth in ultrashort wave and short wave ranges, trajectory measurements, radio telemetry systems. Here the optical equipment which is used during approach is located. /38
At the edges of the panels of the solar batteries are mounted the flying lights for orientation, white, red and green, which are used during coming alongside and docking of ships.

Several sensors are also mounted in the instrument-system module which come into the system for controlling movement of the spacecraft: an ion sensor "for braking" (a second ion sensor "for boost" is located in the orbital module), a sensor for constructing the local vertical according to infrared radiation of Earth and a solar sensor for orientation by the Sun.

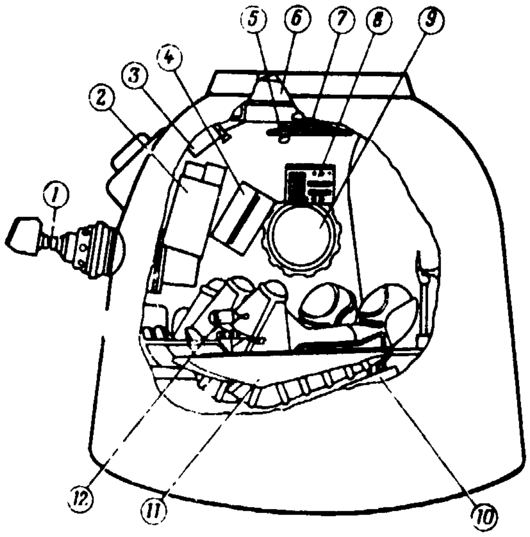



Figure 1. Re-entry Unit of the Soyuz Spacecraft: 1--Optical visual-orientor; 2--Instrument panel; 3--Tele-camera; 4--Command signal device; 5--Television lamp; 6--Hatch access; 7--Hatch control; 8--Control panel for radio stations; 9--Porthole; 10--Instruments and systems for life support; 11--The cosmonaut's armchair; 12--Control sticks.

We continue to go up along the stand and come to the re-entry unit which often is called the cosmonauts' cabin. This is the command room, the operating place for the crew when controlling the craft in flight. The crew is located here when going into orbit and rotating around Earth, and here the basic control panels are located.

In the re-entry unit there are comparatively few parts: two portholes with heat-resistant glass, an optical viewfinder with which one can observe another spacecraft during rendezvous and docking, and also for determining the local vertical and direction of the velocity vector according to the "run of Earth." By the "run of Earth" we mean the visible movement of points of the Earth's surface on the viewfinder screen; if, for example, they move strictly up and down, this means the vehicle is oriented with the nose part forward. In the lower part of the re-entry unit, around its circumference are six engines for orientation; they only operate when the ship is in orbit around Earth.

Turn your attention, if you please, to the different shapes of the re-entry units of the Vostok in which Yu. A. Gagarin flew and the Soyuz: the first has a spherical shape, the second is in a shape which reminds one of a headlight. Making this is not simple: such a shape, with a certain position of the center of gravity, provides the re-entry unit of the Soyuz with aerodynamic lift force during flight in the atmosphere. Its size is regulated by the rotation of the unit around its longitudinal axis. The rotation is made by the same engines for orientation which are mounted in the housing of the launch unit. All this, besides a more precise landing, permitted a considerable decrease in the load factor for the re-entry trajectory (from 8--10 to 3--4 units).

On the entire exterior of the re-entry unit, a heat resistant high-strength coating is applied, and the lower part, susceptible to the greatest intensity of aerodynamic heat during launching, is protected by a heat-protective shield. This shield is jettisoned after the parachute opens, lightening the re-entry unit during landing. When the shield has not yet been mounted in place at the bottom of the re-entry unit one can see the solid propellant engines for a soft landing which are switched on before the touchdown itself. In the upper part of the re-entry unit there are 2 ejection covers over the sections where the parachutes are located--the main parachute and the reserve.

Let us go still higher. Now we come to a series of orbital modules spherical with fairly impressive dimensions. Here the /39
crew rests and also carries out certain scientific experiments. From this same section the crew transfers to the other spacecraft, and during flight of the Soyuz-4 spacecraft and the Soyuz-5 cosmonauts Yu. Khunov and A. Yeliseyev used it as the locking chamber when going out into open space. On the upper hemisphere of the orbital module is the frame on which the new androgynous docking equipment is mounted.

The orbital module has two observation portholes, a side hatch for landing the crew in the spacecraft and a lower hatch for transfer to the re-entry unit.

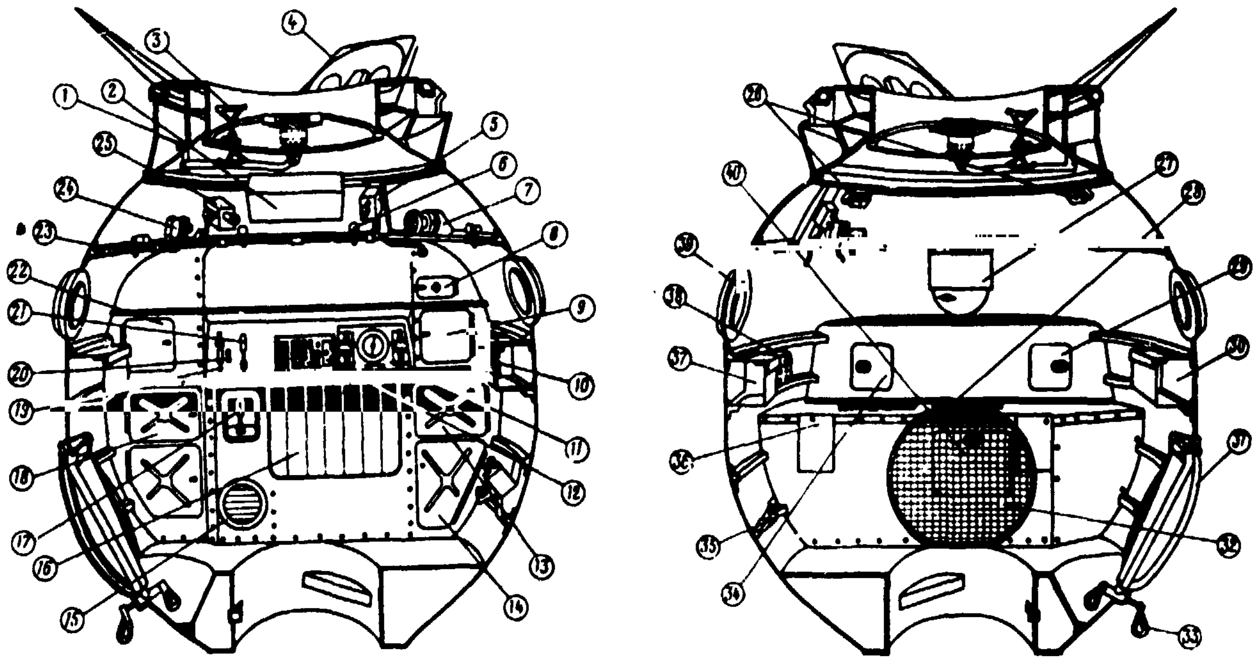


Figure 2. Orbital Section of the Soyuz Spacecraft. Left side: 1--Docking unit; 2--Control block for the docking system; 3--Control wheel for the lock cover; 4--Directional probe of the docking unit; 5--Telecamera; 6--Television lamp; 7--Circulating ventilator; 8--First-aid set; 9--Food rations; 10--Heater for food; 11--A split flap for controlling the hermetic seal of docking and sections of the ship; 12--Orbital module panel; 13--Equipment for personal hygiene; 14--Container for instruments; 15--Grill on the opening for output of air from the heat exchange-condenser; 16--Folding table; 17--Manual pump for evacuating the condenser; 18 and 22--Hatches for access to the sewage disposal device; 19--Drinking device; 20--Safety block; 21--Manual pump for the water supply system; 23--Handrail; 24--Movie camera; 25--Telecamera of the Apollo. Right side: 26--Lamp for working illumination; 27--Gas analyzer; 28--Recording tape; 29--Stowage for space suit hoses; 30--Container for waste; 31--Cover of the landing hatch; 32--Protective grid; 33--Handle for opening the hatch cover; 34--Container for flight documentation; 35--Bracket for the Apollo telecamera; 36--Folding chair; 37--Container for scientific equipment; 38--Distribution box; 39--Porthole; 40--Stowage for space suits.

The cosmonauts can be in the orbital module--which its name explains--only after the craft goes into orbit. This module does not have the strength of the re-entry unit, there are no heat-resistant portholes in it. This is not required when the ship is rotating around Earth; the orbital module, like the instrument-system, is separated from the re-entry unit and upon entry into the dense atmosphere burns up.

Having completed our exterior inspection of the Soyuz spacecraft we will look now at its working accommodations. Here we will move from the top down and we'll go first through the entrance hatch into the orbital module. Here there are light spacious walls (if one can use this word for shperical surfaces) covered with soft decorative material. Along the walls, approximately at head level, are attached handrails which the cosmonauts can hold in order to move in weightlessness. Here is a couch on which the cosmonauts rest, with belts attached almost like an airplane. Inside the couch is located a unit for renewing and purifying the atmosphere, instruments for the orientation system and for movement control. On the left side we see a small stand; in it is a container with drinking water (30 liters) a container with food, the flight first-aid kit, equipment for personal hygiene. Radio equipment for voice communication and for measuring distances between spacecraft is also located here. A small folding table is attached to the stand. Here the cosmonauts will greet their guests from the Apollo.

In the orbital module there are a television camera, movie camera, lights, basic and supplementary (for television transmission) devices for heating food, containers with instruments. Directly overhead--is the hatch cover, the door through which one can go into the neighboring ship after docking. Under the feet of the protective screen, is the protected ransfer manhole hatch. It leads to the re-entry unit.

We raise the screen, open the cover of the hatch and lower ourselves into the command room of the Soyuz. It reminds one somewhat of a pilot's cockpit in an airplane. Here there are two armchairs (in the center is the chair for the commander, to the right of it--for the flight engineer), and directly in front of them--an instrument board.

To the right and left of the instrument board are two identical KSU [Komandno-signal'nyy ustroystva, command signal devices]--command signal devices. Under manual control of the spacecraft with their help, the necessary commands are given for operation of the automatic equipment, and the passage of these commands is controlled. Controlling the systems of the spacecraft can be done simultaneously with both command-signal devices or with /40
either one of them. For manual control of movement of the ship, the crew commander has two levers on his chair: the right is for control for orientation of the spacecraft around the center of its mass, the left--for changing forward speed of the spacecraft during maneuvering.

The re-entry unit and the orbital module are the living accommodations. Here the temperature of the air is maintained in a range of $20 \pm 5^\circ$ C, the general air pressure during automatic flight $760 \pm 100$ mm, mercury column, with partial oxygen pressure, 160--270 mm, mercury column.

The total volume of the habitable section in about 10 cubic meters. The atmosphere in them is cleansed by a purifying unit in the orbital module which is considered basic. It is switched on immediately after the spacecraft goes into orbit. In the sections for re-entry and landing, a purifying unit works in the re-entry unit.

The air in the purifying unit goes from the living sections through a ventilator. It is purified of carbon monoxide, dust, and is enriched with oxygen. The signals for switching on and off the unit are given by the gas analyzer which continuously measures the content of oxygen, carbon monoxide and water vapor in the atmosphere of the craft. The results of these measurements are fed to the cosmonauts' control panel.

The temperature and humidity of the air in the living sections of the Soyuz are maintained at given limits by the heat-exchanger condenser. It is a liquid-air radiator between whose pipes are placed porous wicks for sampling moisture. From the wicks, the moisture goes into a moisture sampler; it is periodically pumped out by a manual pump. For cooling the air with the ventilator it goes through the liquid-air radiator.

The American spacecraft which will participate in the joint flight with our Soyuz spacecraft, is a modified basic Apollo spacecraft created earlier for landing astronauts on the moon. The spaceship block combines two basic modules: command and service. In the present model, the structure of the docking frame is modified; additional plug connection have been mounted on it, changing the postition of flight stowage compartments. The location of the lunar cabin at this time is replaced by a new docking cabin or, to put it another way, a transfer section developed and manufactured by the American side especially for this flight.

In distinction from the Soviet manned spacecraft where the osmonauts breathe air (its composition and pressure approximately the same as on Earth) the atmosphere for all American spacecraft is artificial--on the Mercury, Gemini, Apollo, it is pure oxygen with gas pressure 0.35--0.38 atmospheres. Recently the American specialists agreed that for future manned equipment it is best to /41 have an atmosphere with the composition of that on Earth. This not only decreases the danger of fire but also makes it considerably easier for the crew of spacecraft from different countries

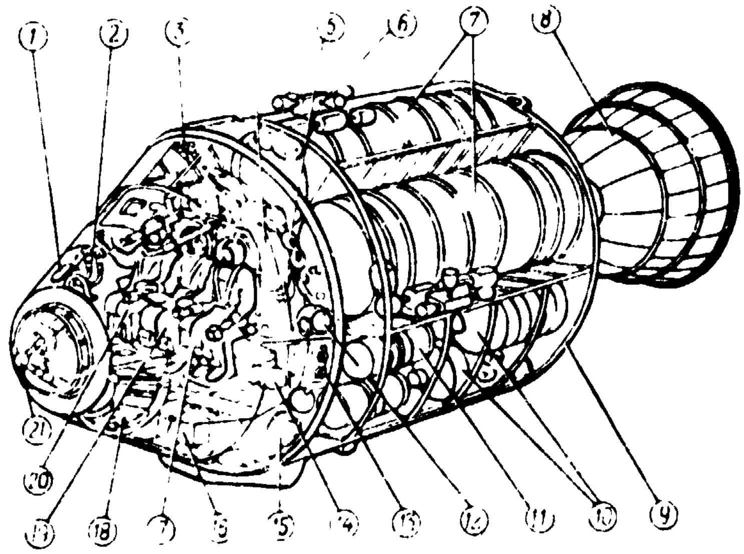


Figure 3. Basic Block of the Apollo Spacecraft: 1--Braking parachutes; 2, 3, 5 and 13--Orientation engines; 4--Storage compartment; 6--Block for auxiliary engines; 7--Fuel tanks for cruising propulsion unit; 8--Cruising propulsion unit; 9--Service module; 10--Tanks with hydrogen and oxygen for fuel elements; 11-Hydrogen-oxygen fuel elements in the service module; 12--Tank with drinking water; 14--Fire extinguisher; 15--Fuel tanks for the engines of the orientation system of the command module; 16--Section for storage of food products; 17--Location of the spacecraft commander; 18--Basic parachutes; 19--Location of the pilot of the basic block; 20--Location of the pilot for the docking (transfer) module; 21--Docking pintle.

to cooperate in space. However, this is work for the future and in the first joint flight for transfer of the cosmonauts from one spacecraft to another a special chamber will be needed for equalizing pressure. Its role will be carried out by the docking (transfer) module in the Apollo.

Thus, the spacecraft Apollo in this flight will be made up of three basic modules: command, service and docking (transfer).

If one presents an analogy with our Soyuz spacecraft, the command module of the Apollo will correspond to the re-entry module of the Soyuz, the service with the instrument-system. There is no analogy for our orbital module on the Apollo.

For our excursion on the Apollo we will begin with the command module. The American astronauts will be here for the entire flight from start to rotation around Earth, will work and rest here. From here they will control the spacecraft, carry out scientific research and experiments. The module has the shape of a cone with a rounded off top; its frame actually consists of three smaller compartments: the forward compartment, the compartment for the crew and the rear, or bottom compartment.

The forward compartment is built around the hatch through which the American astronauts will transfer to our spacecraft.

At the entrance to this hatch is mounted a removable docking unit of the pin-cone type connecting the transfer module with the Apollo. The pintle is on the Apollo but the cone--on the transfer module.

During re-entry before opening the parachutes the upper part of the forward compartment is separated, disclosing the equipment located here: dischargers for firing the braking and pilot parachutes, the basic parachutes, inflatable balloons, which keep the command module and other devices in a vertical position after landing on the water.

The center part of the command module contains the hermetically sealed crew cabin. A row of three chairs are suspended on shock absorbers in it; the center chair folds so that before the start it is easier for the astronauts to check the equipment, and in flight--to operate with optical instruments. The American astronauts take turns sleeping in the left armchair which is outfitted with a suspended hammock. In the left chair, during the joint flight will be the ship commander, and in the middle--the pilot for the main block and in the right--the pilot for the docking module.

In the crew's cabin there are several control panels: the main panel--in front of the commander's chair, the auxiliary--to the right and behind. Control of the spacecraft in flight is carried out using the panel of instruments. Checking the operation of the systems before starting and in flight is done by instruments from one of the auxiliary panels. The navigational equipment is located at the base of the center chair. To the side of the outside chairs and behind them in cupboards are reserve food and scientific equipment.

As in the re-entry module of the Soyuz, all of the equipment for the command module of the Apollo is arranged so that the center of mass of the compartment lies at a certain distance from the longitudinal axis. As a result, when the module enters the atmosphere a specified lift force occurs. Using the orientation motors, the command module rotates around its longitudinal axis, changes its angle of attack, and this permits carrying out the necessary maneuvers for leaving orbit.

Usually the command module of the Apollo enters the water. But measures have been adopted in case the module lands on dry land. In order to do this on one side it has probes which when hitting the Earth crumple and decrease the shock loads. And so that the module will hit on these projections, the parachute straps are attached unsymmetrically.

The astronauts enter the crew cabin and leave it through an escape hatch in the side wall. In the transfer (locking) module during the joint flight they will move through a tunnel and lock in the upper part of the cabin. There are four windows in the cabin: two in front and two on the side.

Under the crew's cabin, in the rear or bottom compartment, there are 10 of the 12 jet engines mounted, which control the spatial position of the craft during re-entry (two engines are in the forward compartment) and here are located the tanks with fuel and the cylinders with compressed gas from all 12 engines, the containers for the drinking water.

The entire surface of the command module (except for the windows and nozzles of the engines for the orientation systems) are covered by heat-protective shields made of glass plastic with removable filling. The greatest thickness is in the bottom part more than 6 cm.

Using the transfer structure, the command module is joined with the cylindrical service (or as it is called engine) module. The distribution of the command and service modules occurs before entry into the dense layers of the atmosphere using explosive charges which simply destroy the elements of the connective structures.

In the service module are mounted the cruise propulsion unit fuel tanks, batteries which provide the Apollo with electrical energy, and the system of jet control of the spatial position of the spacecraft. The housing of the module is laminar, made from aluminum alloy. Radiator pipes are mounted in the walls in which liquid circulates, removing heat from the operating equipment. Regulation of the temperature of the housing is also provided by painting part of the surface with a composition with a high coefficient of reflection, and part of the surface--with a composi- /42 tion with high coefficient of absorption of solar rays. The bottom part of the service module is cover with a shield which protects the equipment placed here from the heat of exhaust gases from the nozzle.

Looking at the service module of the Apollo we undoubtedly turn our attention to the huge nozzle of the cruise propulsion engine. This engine creates a thrust force for all large changes in velocity of flight. But each increase or decrease of orbital velocity leads to a change in the orbit. When this velocity becomes smaller than the first space velocity, the craft leaves orbit and descends. The orientation of the Apollo in space, its stabilization of position in flight is provided by a system of jet control. The latter is divided into two completely independent parts: a system of jet control of the service module and a system of jet control of the command module. Before separating the command module from the service (we remind you that the separation occurs before reentry) the orientation and all the small shifts of the spacecraft are carried out by a system of jet control in the service module. This is a final control element--4 identical bands of jet engines, symmetrically placed around the module. Inasmuch as, this time, the cruise propulsion unit of the Apollo will operate less than on flights to the Moon, the fuel reserve for it is decreased. And in this connection, where more maneuvering is required in the orbit around the Earth, the supply of fuel for auxiliary engines will be increased. This fuel can be necessary for bringing the spacecraft out of orbit if the cruise propulsion unit breaks down.

A new element in the Apollo spacecraft in the coming flight, as we have already said, will be the transfer (docking) module, a cylinder with a diameter of about 1.6 m and length 3.15 m. On both its ends are mounted docking units: one--a cone for joining Apollo, the other--a new androgynous--peripheral unit for docking for joining with the Soyuz. The unique exterior elements of this module are communication antennas and 4 spherical tanks with oxygen and nitrogen systems for life support which operate during transfer of the cosmonauts and astronauts from spacecraft to spacecraft.

One of the hatches of the transfer module is in the Apollo. This hatch is equipped with a sensor for pressure drop, a valve for equalizing pressure and a mechanism for opening from both sides. The hatch of the transfer module converted for the Soyuz has a new cover and also a sensor for pressure drop and a valve /43
for equalizing pressure.

Now let us look inside the transfer module. Its volume is not so small: two men can be here at the same time. The module has special systems for life-support and heat regulation; oxygen and nitrogen is supplied depending on whether cosmonauts are going from the Soyuz to the Apollo or the reverse. The indicator panel and control for the life support system is inside the module in its lower part. In case of breakdown in the hermetic seal of the compartment swift supply of gases necessary for breathing is planned. The carbon monoxide given off by the cosmonauts when breathing is removed from the atmosphere of the module by absorbers (replaceable lithia mica cartridges) similar to those used in the command module of the Apollo.

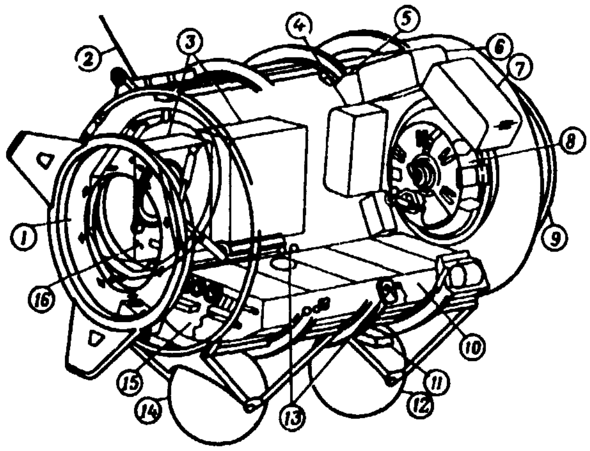



Figure 4. Docking (Transfer) Module of the Apollo Spacecraft: 1--Androgynous docking unit; 2--Radio communication antenna; 3--Containers with equipment; 4--System for supplying oxygen; 5--Lamp; 6--Emergency system for oxygen supply; 7--Container; 8-Hatch cover (in closed position); 9--Unit for docking with the Apollo ship; 10--Equipment block; 11--Drainage aperture for reducing pressure; 12--Spherical tank with oxygen; 13--Levers for controlling the lifesupport system; 14--Spherical tank with nitrogen; 15--Panel for indications and control of the equipment block; 16-- Hatch cover (in open position).

Inside the module, transmitter-receiver headphone communication is set up for conversing with the crew of the Soyuz spacecraft. Direct voltage (27 volts) for supplying the system of

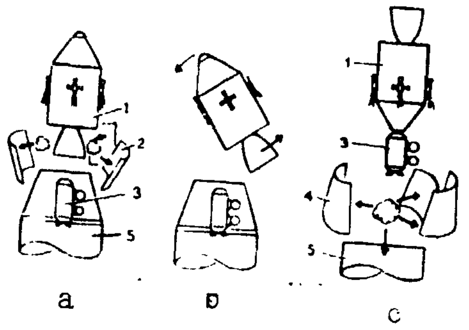



Figure 5. Exemplary Diagram of a Reconstructed Section of the Apollo Spacecraft: a--Jettison of part of the adaptor between the rocket carrier and the main block of the spacecraft; b--Turn of the basic block (by 180°); c--Docking of the main block with the transfer module, jettison of the lower part of the transfer module and separation of the rocket carrier. 1--Basic block of the Apollo spacecraft; 2--Upper part of the adaptor; 3--Docking module; 4--Lower part of the adaptor; 5--Rocket carrier.

the module and for illumination and also alternating voltage (115 volts) for the motors of the androgynous docking unit with the Soyuz, are supplied from on board the Apollo spacecraft.

The electrical energy on the Apollo is supplied by batteries of fuel elements which operate on oxygen and hydrogen. The drinking water is pumped over from the service module where the batteries are located, into the container in in the command module. Besides the fuel elements, the spacecraft has silver-zinc storage batteries which are utilized as additional energy sources for short-term peak loads in flight and as basic sources for supplying the system of the command module during re-entry.

The transfer (docking) module which in the joint experiment must be in the nose part of the Apollo during the start is placed on the opposite side between the second stage of the rocket carrier and the basic block of the spacecraft. After going into orbit, the American astronauts plan to reconstruct and reattach the transfer compartment to the spacecraft. To do this they will separate the basic block of the spacecraft from the rocket carrier and being in line with it turn the Apollo by 180° approach to the transfer module and rejoin with it. Then, the final separation of the transfer module, it is understood, together with the spacecraft

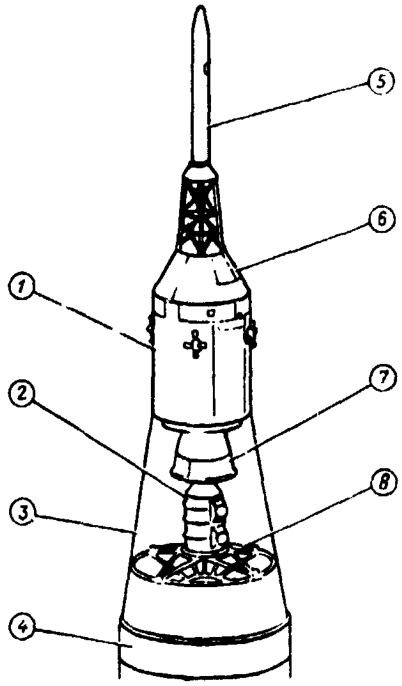



Figure 6. Arrangement of the Main Block and Transfer (Docking) Module of the Apollo Spacecraft During Starting: 1-Service module; 2--Docking module; 3--Adaptor between the spacecraft and rocket-carrier; 4--Rocket-carrier; 5--System for emergency rescue; 6--Command compartment; 7--Nozzle of the cruise propulsion engine; 8--Structure for attaching the docking (transfer) module to the rocket carrier.

will separate from the rocket carrier and the Apollo will be ready to carry out maneuvers in approaching the Soyuz.

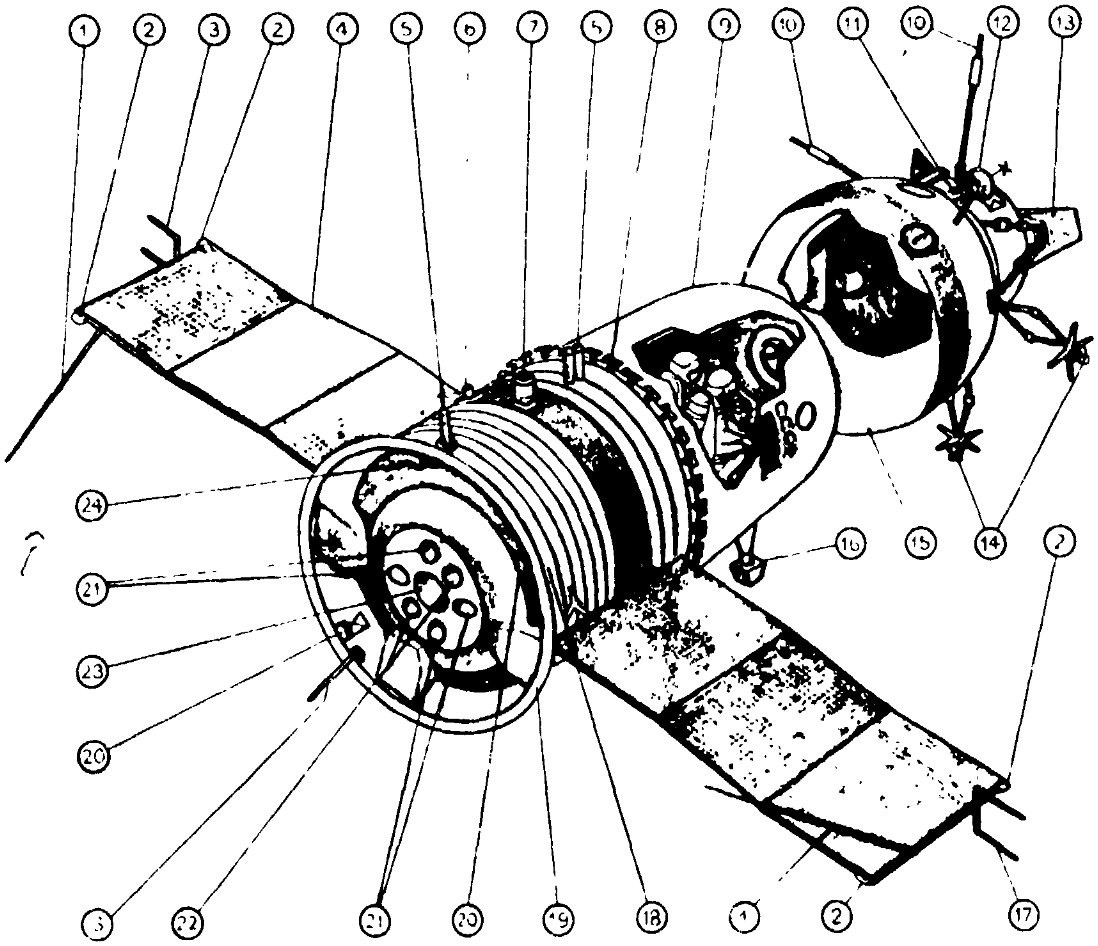
In the coming experiment, the Apollo will be the active spacecraft. Therefore, for radar detection and guidance on the Soyuz there will be mounted a transponder for the Apollo. Moreover, the Soyuz will be equipped with two pulse markers whose light can be observed by the naked eye for a distance up to 50 km.

Data on the angle for guiding for the approach module for the Apollo crew will be obtained by using a sextant, sighting it on the Soyuz marker;and information from a distance--from an ultra short wave-responder, also mounted on the Soyuz. In the rendezvous portion, the crew of the spacecraft uses flight lights for orientation, a docking target, and also viewing devices on the Apollo.

Before touching, when especially precise orientation is required, the cosmonauts will control the position of the spacecraft according to the docking target of the Apollo type mounted on the orbital section of the Soyuz. The latter was used during flight of the Apollo to the moon for docking the main block with the lunar module.

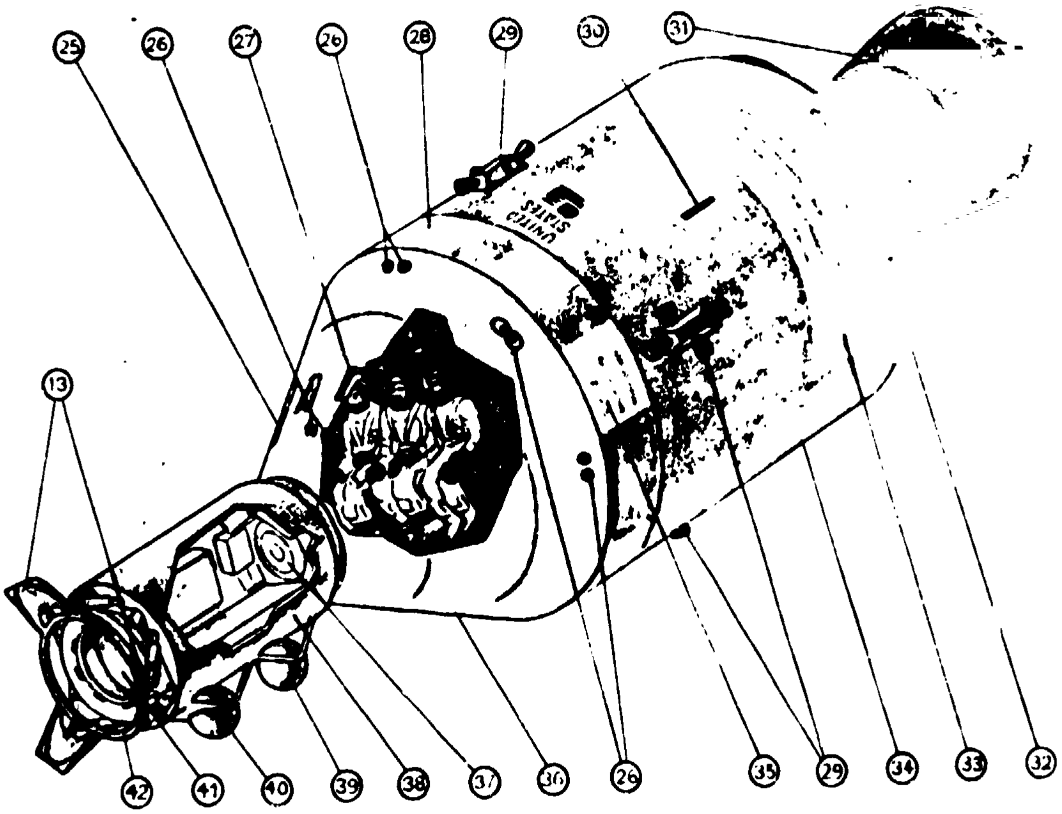
Soviet and American specialist--scholars, cosmonauts, workers, have done a tremendous job in preparation for the first joint international space flight in the world. This flight, undoubtedly, will be an important landmark in the mastery of outer space by the combined forces of different countries.

Soyuz and Apollo--the Space Vehicles for the Joint Flight



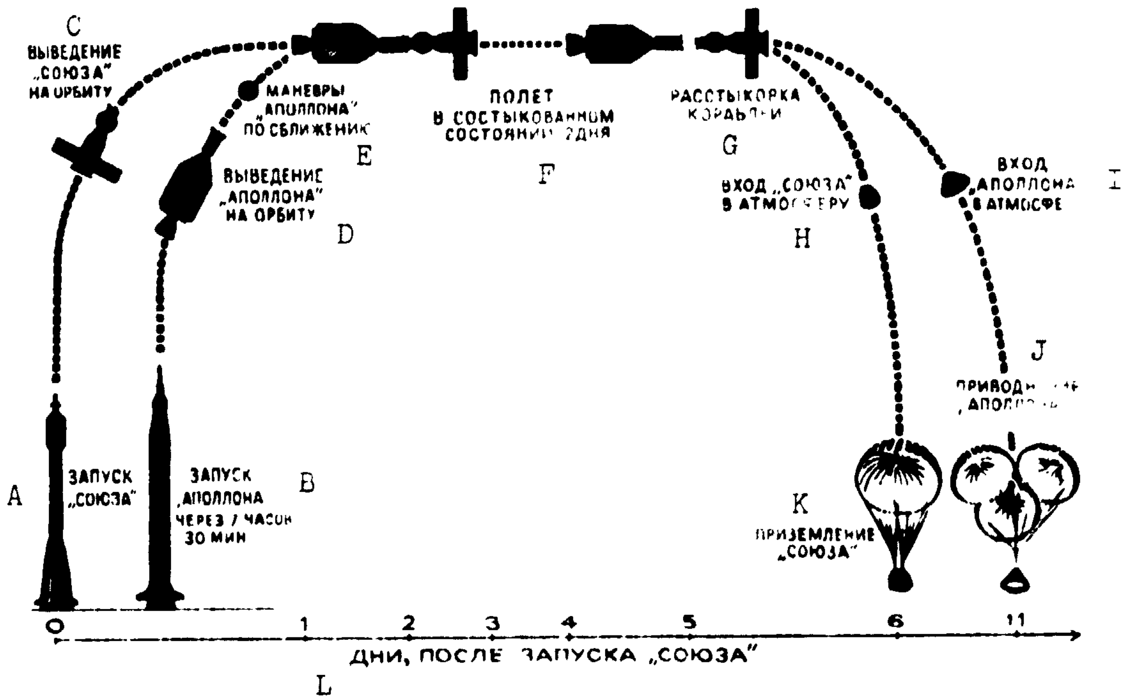

The Soyuz Spacecraft: 1--Short wave antenna; 2--Flying lights; 3--Radio-telemetric system antenna; 4--Solar battery panel; 5--Engine for mooring and orientation; 6--Pulse beacon; 7--Sensor for solar orientation; 8--Antenna for the command microwave length; 9--Reentry unit; 10--Ultra short wave FM antenna; 11--Exterior television camera; 12--Docking target; 13--Directional probe of the docking module; 14--Ultra short wave AM antenna; 15--Orbital module; 16--Optical viewfinder-orientator; 17--Ultra short wave antenna; 18--Radiator for the thermal regulation system; 19--Instrument-system section; 20--Ion sensor "for braking"; 21--Steering jets; 22--Duplicate correcting engine; 23--Basic approaching-correcting engine; 24--Antenna for radio telemetric system

Soyuz and Apollo--the Space Vehicles for the Joint Flight, cont.




The Apollo Spacecraft: 25--Escape hatch in the side wall of the command module; 26--Engines for control during re-entry; 27--Window; 28--Transfer module; 29--Block of auxiliary engines; 30--Antenna for metric range; 31--Jet of the cruise propulsion engine; 32--Heat protecting shield on the bottom of the service module; 33--Heat regulation radiator in the life support system; 34--Service module; 35--Radiator for heat regulation in the electrical supply system; 36--Command module; 37--Lock between the spacecraft and the docking module; 38--Docking module; 39--Spherical cylinder with oxygen; 40--Spherical cylinder with air; 41- Hatch of the docking unit; 42--Docking unit.

Soyuz and Apollo--the Space Vehicles for the Joint Flight cont.




A--Launch of the Soyuz; B--Launch of the Apollo after 7 hours 30 minutes; C--Entry of the Soyuz into orbit; D--Entry of the Apollo into orbit; E--Maneuvers of the Apollo in the Approach; F--Flight in docked condition--2 days; G--Disconnection of the vehicles; H--Reentry of the Soyuz into the atmosphere; I--Reentry of the Apollo into the atmosphere; J--Water landing of the Apollo; K--Ground landing of the Soyuz; L--Days after launch of the Soyuz